Cenovus EnCAID project
Approval #10440L
Performance presentation
Advisory

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Cenovus EnCAID* introduction and overview

This presentation was prepared in accordance with AER Directive 054 - Performance presentations, auditing, and surveillance of in situ oil sands schemes

Subsurface issues related to resource evaluation and recovery
  • Directive 054, Section 3.1.1

Surface operations, compliance, and issues not related to resource evaluation and recovery
  • Directive 054, Section 3.1.2

* Canadian patent CA2594413 (C)
AER Directive 054 Section 3.1.1

Subsurface issues related to resource evaluation and recovery
Subsurface issues: table of contents

- Background
- Geology/geoscience
- Drilling and completions
- Instrumentation
- Scheme performance
- Future plans
Scheme background

Subsurface section 1
Background

• The EnCAID project is an enhanced recovery scheme which displaces natural gas with combustion gases that are the result of combustion of residual bitumen in gas cap.
Project overview

- Combustion of residual bitumen in gas cap
- Allows for displacement and repressurization of gas zone
- 100% Cenovus Energy Inc.
Geological/geoscience
Subsurface section 2
Summary of Wabiskaw gas properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>465 TVD</td>
</tr>
<tr>
<td>Thickness</td>
<td>5 m</td>
</tr>
<tr>
<td>Average porosity</td>
<td>~36%</td>
</tr>
<tr>
<td>Average gas saturation</td>
<td>~50%</td>
</tr>
<tr>
<td>Average water saturation</td>
<td>~30%</td>
</tr>
<tr>
<td>Average bitumen saturation</td>
<td>~20%</td>
</tr>
</tbody>
</table>
Wabiskaw stratigraphic cross-section
Drilling and completion

Subsurface section 3
Well layout
Drilling and completion

- No new wells were drilled
- No recompletions
- No workovers

Requirements under subsection 3.1.1 3c – wellbore schematics are included in the appendix
Instrumentation

Subsurface section 5
Instrumentation in wells

Observation Well: 102/05-10-73-6W4
• Equipped with three piezometers
• Equipped with 10 thermocouples

Observation Well: 100/6-10-73-6W4
• Equipped with one piezometer
• Equipped with 10 thermocouples

Requirements under subsection 3.1.1 5a – wellbore schematics 5c and 5d are included in the appendix
Observation wells bitumen pressure

Recent data not available due to instrumentation issues
102/05-10-073-06W4 – Temp history
102/05-10-073-06W4/0
Observation well temperature
Scheme performance

Subsurface section 7
## Project performance history

<table>
<thead>
<tr>
<th>Year</th>
<th>Activity</th>
<th>Year</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>June: Ignition and start-up</td>
<td>2012</td>
<td>Jul: 00/6-7-76-6W4/00 startup&lt;br&gt;Oct: Primrose sales volumes flowing to Caribou gas facility</td>
</tr>
<tr>
<td>2007</td>
<td>Q1: 00/14-9-73-6W4/00 nitrogen response a&lt;br&gt;Q2: 00/2-16-73-6W4/00, 00/11-15-73-6W4/00 nitrogen response. 00/14-9-73-6W4/00 shut-in</td>
<td>2013</td>
<td>Feb: 00/6-6-73-6W4/00 startup of&lt;br&gt;Mar:00/7-8-73-6W4/00 shut-in</td>
</tr>
<tr>
<td>2008</td>
<td>May: Nitrogen response at 00/1-17-73-6W4/00</td>
<td>2014</td>
<td>Dec: 00/10-12-73-7W4/00 startup</td>
</tr>
<tr>
<td>2009</td>
<td>Jan: 00/6-18-73-6W4/00 gas production shut-in due to segregation repair&lt;br&gt;Jun: 00/7-8-73-6W4/00 nitrogen response&lt;br&gt;Oct: Injectivity decrease observed</td>
<td>2016</td>
<td>Feb: 00/11-15-73-6W4 abandoned&lt;br&gt;Jul: S00/10-11-73-7W4/00 startup</td>
</tr>
<tr>
<td>2010</td>
<td>Q1: 00/5-10-73-6W4/00 injector stimulation treatment&lt;br&gt;Q4: 00/1-17-73-6W4/00, 00/2-16-73-6W4/00, 00/11-15-73-6W4/00 shut-in. 00/5-10-73-6W4/00 removal of thermocouple string and perform pressure fall off tests</td>
<td>2017</td>
<td>Mar/Apr: Production shut-in due to non-compliance event&lt;br&gt;Aug: 00/06-05-073-06/W4 shut-in&lt;br&gt;Oct: 00/10-11-073-06W4 returned to production at restricted rate</td>
</tr>
<tr>
<td>2011</td>
<td>Q1: 00/5-10-73-6W4/00 injector stimulation treatment&lt;br&gt;Mar/Apr: 00/11-15-73-6W4/00 flowed N₂ 85%</td>
<td>2018</td>
<td>Mar: 00/06-07-073-06W4/02 shut-in&lt;br&gt;Sept: 00/06-06-073-06W4/02, 00/10-11-073-07W4/00, 00/10-12-073-07W4/00 shut-in&lt;br&gt;Cenovus divested the EnCAID wells and facilities effective September 2018.</td>
</tr>
</tbody>
</table>
## Production/injection summary

### Production operations

<table>
<thead>
<tr>
<th>Operating for</th>
<th>Air injected</th>
<th>Bulk gas recovered</th>
<th>Formation gas recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;12 years</td>
<td>~ 305 e^6 m^3</td>
<td>~ 217 e^6 m^3</td>
<td>~ 192 e^6 m^3</td>
</tr>
</tbody>
</table>

### Approved producers

<table>
<thead>
<tr>
<th>UWI</th>
<th>Status</th>
<th>UWI</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>00/06-05-073-06W4/0</td>
<td>Shut-in ~ 81% N_2</td>
<td>00/02-16-073-06W4/0</td>
<td>Shut-in ~ 85% N_2</td>
</tr>
<tr>
<td>00/06-06-073-06W4/2</td>
<td>Flowing * ~2% N_2</td>
<td>00/01-17-073-06W4/0</td>
<td>Shut-in ~ 86% N_2</td>
</tr>
<tr>
<td>00/06-07-073-06W4/2</td>
<td>Shut-in ~79% N_2</td>
<td>00/10-11-073-07W4/0</td>
<td>Flowing * &lt;1% N_2</td>
</tr>
<tr>
<td>00/07-08-073-06W4/0</td>
<td>Shut-in ~87% N_2</td>
<td>00/10-12-073-07W4/0</td>
<td>Flowing * &lt;1% N_2</td>
</tr>
<tr>
<td>00/11-15-073-06W4/0</td>
<td>Abandoned</td>
<td>00/14-09-073-06W4/0</td>
<td>Shut-in ~ 85% N_2</td>
</tr>
</tbody>
</table>

* All wells shut-in Sept 2018
K3 pool production

* Average 2018 production until Sept shut in

Injection Well

SI K1 or L3 Pool

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April 15, 2019
History production
January to September
Managed air injection to minimize operating costs with intermittent high air injection rates to ensure that the minimum monthly VRR of 0.90 was met.

Cenovus divested the EnCAID wells and facilities effective September 2018.
## Voidage replacement ratio

<table>
<thead>
<tr>
<th></th>
<th>Monthly VRR</th>
<th>Cumulative VRR</th>
<th>VRR regulatory approved limit (Min monthly)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1.30</td>
<td>1.42</td>
<td>0.90</td>
</tr>
<tr>
<td>February</td>
<td>1.30</td>
<td>1.42</td>
<td>0.90</td>
</tr>
<tr>
<td>March</td>
<td>1.20</td>
<td>1.42</td>
<td>0.90</td>
</tr>
<tr>
<td>April</td>
<td>1.00</td>
<td>1.42</td>
<td>0.90</td>
</tr>
<tr>
<td>May</td>
<td>1.20</td>
<td>1.41</td>
<td>0.90</td>
</tr>
<tr>
<td>June</td>
<td>1.10</td>
<td>1.41</td>
<td>0.90</td>
</tr>
<tr>
<td>July</td>
<td>1.00</td>
<td>1.41</td>
<td>0.90</td>
</tr>
<tr>
<td>August</td>
<td>1.00</td>
<td>1.41</td>
<td>0.90</td>
</tr>
<tr>
<td>September</td>
<td>1.10</td>
<td>1.41</td>
<td>0.90</td>
</tr>
<tr>
<td>October</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>November</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>December</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* Cenovus divested the EnCAID wells and facilities effective September 2018.
VRR performance

* Note: The Cumulative VRR since 2015 has been updated.
Due to an error in the calculation, the previously reported values were higher than actuals.
VRR history

![VRR history chart](image-url)
K3 pool pressure
Observation 6-10 well temperature
Composition of injected/produced fluids

- EnCAID does not currently sample air injected
- EnCAID captures gas samples for analysis on the schedule located to the right and monitors compositional changes for each well
- Cenovus samples selective wells on more frequent basis than required under Approval 10440L

<table>
<thead>
<tr>
<th>Sampling Frequency</th>
<th>Date Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual</td>
<td>00/01-17-073-06W4/0</td>
</tr>
<tr>
<td>Annual</td>
<td>00/02-16-073-06W4/0</td>
</tr>
<tr>
<td>Semi-annual</td>
<td>00/06-05-073-06W4/0</td>
</tr>
<tr>
<td>Semi-annual</td>
<td>00/06-06-073-06W4/2</td>
</tr>
<tr>
<td>Semi-annual</td>
<td>00/06-07-073-06W4/2</td>
</tr>
<tr>
<td>Annual</td>
<td>00/06-10-073-06W4/2</td>
</tr>
<tr>
<td>Annual</td>
<td>00/06-18-073-06W4/0</td>
</tr>
<tr>
<td>Annual</td>
<td>00/07-08-073-06W4/0</td>
</tr>
<tr>
<td>Semi-annual</td>
<td>00/10-11-073-07W4/0</td>
</tr>
<tr>
<td>Semi-annual</td>
<td>00/10-12-073-07W4/0</td>
</tr>
<tr>
<td>Annual</td>
<td>00/10-36-072-07W4/2</td>
</tr>
<tr>
<td>Annual</td>
<td>00/11-17-073-06W4/0</td>
</tr>
<tr>
<td>Annual</td>
<td>00/14-09-073-06W4/0</td>
</tr>
</tbody>
</table>
Wabiskaw K-3 Pool material balance

Original Pressure – 2050 kPaa (300 psia)

Pressure Dec 03 = 662 kPaa or 96 psia
OGIP = 1129 $\times 10^6$ m$^3$ (39.9 Bcf)
Gas prod = 877 $\times 10^6$ m$^3$ (31.0 Bcf 77% RF)

Dec/2017
Cum Prod $1,088$ $\times 10^6$ m$^3$ (38.7 bcf)
RF 97%

Pre-EnCAID
EnCAID
Subsurface key learnings

Presence of more than one oxidation front indicates

- fuel remaining in the region swept by the combustion front
- could be either residual oil left behind first oxidation front, or re-saturation with oil from adjacent rock or, possibly from flammable vapor produced from the oxidation and cracking reactions

Continues to be strong correlations between air-injection rate and temperature changes

- first oxidation zone at the bottom of the gas cap was truncated by a reduction in injection rate
- increase in injection rate performed in early 2013 resulted in ignition and combustion of the top of the bitumen
Future plans

Subsurface section 8
Future plans

- Cenovus divested the EnCAID well and facilities effective September 2018 and plans to transfer the scheme approval to the new owner.
AER Directive 054 Section 3.1.2

Surface operations, compliance and issues not related to resource evaluation and recovery
Surface operations: table of contents

- Facility overview/modifications
- Measurement and reporting
- Environmental issues
- Compliance statement
- Future plans
Facilities Overview

Surface section 1
Site Layout
Process flow schematic
Plant performance - 2018

Facility is operating as expected
  • Steady air injections
  • Operated to optimize operating costs
Gas usage

Usage is as fuel gas for air compressor operations

- Gas source Primrose plant fuel gas
- Total 2018 usage 824 e$^3$m$^3$*

* All wells & air injection shut-in Sept 2018
# Greenhouse gas emissions

<table>
<thead>
<tr>
<th>Month</th>
<th>2018 (tonnes CO2e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>368.67</td>
</tr>
<tr>
<td>February</td>
<td>287.56</td>
</tr>
<tr>
<td>March</td>
<td>331.13</td>
</tr>
<tr>
<td>April</td>
<td>243.76</td>
</tr>
<tr>
<td>May</td>
<td>231.82</td>
</tr>
<tr>
<td>June</td>
<td>238.62</td>
</tr>
<tr>
<td>July</td>
<td>244.90</td>
</tr>
<tr>
<td>August</td>
<td>221.46</td>
</tr>
<tr>
<td>September</td>
<td>70.82</td>
</tr>
<tr>
<td>October</td>
<td>0.00</td>
</tr>
<tr>
<td>November</td>
<td>0.00</td>
</tr>
<tr>
<td>December</td>
<td>0.00</td>
</tr>
</tbody>
</table>

* All wells & air injection shut-in Sept 2018
## 2018 Annual Venting and Flaring Volumes

<table>
<thead>
<tr>
<th>SO₂ (tonnes)</th>
<th>NOₓ (tonnes)</th>
<th>Venting (e³m³)</th>
<th>Flaring (e³m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10.577</td>
<td>24.86</td>
<td>0</td>
</tr>
</tbody>
</table>
Surface facility key learnings

- Safe operation of production and injection wells
- Geographical location provides challenges for instrumentation operations utilizing solar panels during the winter season
- Purity of injection gases plays key role in maintaining injectivity
- Marginal economics to operate in today's pricing environment
Measurement and reporting

Surface section 2
Measurement reporting

Field Operations record daily flow volumes for air injection and compressor usage

EnCAID Daily Volumes report spreadsheet

Production activities
1) PA updates gas analysis in PAS
2) PA enters air volumes and fuel usage volume from EnCAID Daily Report into PAS EnCAID injection facility
3) Well production PVR data uploaded to PAS
4) PAS generates PRA submission
5) PA manually updated the gas fuel usage and air injection into PRA

Gas Analysis

Gas well meters loaded to PVR via SCADA system

PVR
Environmental issues

Surface section 7
Environmental compliance

No environmental non-compliance events related to EnCAID occurred in 2018
Compliance statement

Surface section 8
Compliance confirmation

There were no non-compliance events related to EnCAID Approval 10440L in 2018
Non-compliance discussion

Surface section 9
Non-compliance discussion

There were no non-compliance events related to EnCAID Approval 10440L in 2018
Future plans

Surface section 10
Future plans

- Cenovus divested the EnCAID well and facilities effective September 2018 and plans to transfer the scheme approval to the new owner.
Appendix
Gas composition 00/1-17-73-6W4/0
Gas composition 00/2-16-73-6W4/0
Gas composition 00/6-5-73-6W4/0
Gas composition 00/6-6-73-6W4/0
Gas composition 00/6-7-73-6W4/0
Gas composition 00/7-8-73-6W4/0
Gas composition 00/10-11-73-7W4/0
Gas composition 00/10-12-73-7W4/0
Gas composition 00/6-18-73-6W4/0
## Downhole Instrumentation Layout

### Observation Well
- **102/05-10-072-66W4**
- **Temp °C**: 7.93, 7.90
- **mGL**: 300.0, 430.0
- **116.24**

### Production and Obs Well
- **100/06-10-073-66W4**
- **Temp °C**: 300.0, 430.0
- **mGL**: 0.13, 11.84

**TRENDS**
- Higher AEBU zonal isolation reading
- Above Zone comparison to Wolf Lake (10 meters above zone)
- Top of gas zone (1,012.4 mPL)
- Heart of gas zone (435.0 mPL)
- Bottom of gas zone (1,043.7 mPL)

**Pressures**
- 1 meter below G/B interface (1,943 mPL)
- 2 meters below G/B interface (1,943 mPL)
- 4 meters below G/B interface (1,943 mPL)
- 7 meters below G/B interface (1,943 mPL)
- 11 meters below G/B interface (1,943 mPL)
- 15 meters below G/B interface (1,943 mPL)
- 25 meters below G/B interface (1,943 mPL)

**Additional Information**
- **139.63, 159.81, 184.06, 176.75, 159.14, 134.60, 108.07**
- **13.75 MPa**
100/05-10-073-06W4 wellbore schematic
102/05-10-073-06W4 wellbore schematic
103/05-10-073-06W4 wellbore schematic